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The Dark Star of Baisun-tau: a history of cave exploration in Southern Uzbekistan, 1990–2013.

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Summary: Very little is known about the karst and caves in southern Uzbekistan, where some of the deepest caves in Asia have been discovered. In particular, the limestone plateau of the Baisun-tau mountain range has a tremendous potential for exploration. This region is also important for palaeoclimate studies, as it is situated in the transition zone between the Westerlies and the Indian Summer Monsoon. For more than 15 years *Festival'naya Cave*, now the *Festival'naya–Ledopadnaya* cave system, was the main focus of cavers' attention. Then, in 2011 the great potential of *Dark Star Cave* was revealed, after extensive new discoveries were made. Since then, additional expeditions with international teams of cavers, led by the Ekaterinburg Speleological Club and with the support of the Speleological Association of the Urals (SAU, Russia), have continued the exploration of these unique high altitude caves of the Baisun-tau. Both the length and depth of *Dark Star* have been increased almost two-fold every year. So far, six entrances and 9,537m of surveyed passages have been discovered to a depth of −858m, and *Dark Star* has now become the focus of exploration for expeditions to the area.

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The Baisun-tau mountain range is located in Southern Uzbekistan in Central Asia, in the remote triangle between Turkmenistan, Tajikistan and Afghanistan, around 67°E and 38°N (Fig.1). Semi-desert conditions with very cold winters and hot, dry summers characterize this region, which falls within the Csa to BSk climate subdivisions in the Köppen-Geiger classification (Peel *et al.,* 2007). Typically, rain and snow are observed only between October and April, with considerable quantities of snow in the mountains (Aizen *et al.,* 1996; Breitenbach *et al.,* 2013). Summer rainfall is scarce and normally the result of local thunderstorms. However, the high altitude of the plateau, between 3,500–3,900m above sea level (a.s.l.), also allows snowfall during the summer, as experienced in 2012.

Figure 1: *Maps to show the location of Uzbekistan in its global context and relative to neighbouring countries in central Asia, together with the location of the area of explorations: Hodja-Gur-Gur-Ata, in the Baisun-tau mountain range, Baisun region, Surxondaryo province, Uzbekistan. (Photo by S Guarniero, 2012)*

On the way to the wall (photo by S Guarniero, 2012).

The mountains are accessible only with donkeys, via tracks from the nearest villages, which takes several days. Helicopter transport is both extremely difficult to organize and very expensive, due to military restrictions for civil air traffic near the border with Afghanistan, and it can be considered only in cases of absolute emergency.

Access for international visitors is also difficult, due to visa and other official requirements. As the Baisun-tau mountain range lies close to the border with Afghanistan, special permits must be acquired from the appropriate authorities in the town of Termiz. During recent years, there has been some confusion among the various responsible governmental organizations, and how caving tourists should be dealt with, and by whom, remains unclear. It is important that western visitors should pay close attention to local customs and traditions in this remote rural area. For example, women cannot walk freely everywhere in the countryside, especially not if wearing casual clothing. Such cultural aspects should be considered carefully when planning visits to the region.

The Baisun-tau mountain range stretches 50km from southwest to northeast, with absolute altitudes of its sub-ridges ranging from 3,500 to 3,900m a.s.l. (Tsurikhin *et al.,* 2013; Klimchouk, 2004). Running parallel to the Baisun-tau, about 15km to its southeast, is the Surkhan-tau range. The Baisun-tau itself consists of two main mountain chains – Ketmen' Chapty and Hodja-Gur-Gur-Ata – which are both monoclinal structures with gently descending (10–25°) plateau-like northwestern slopes and characteristically steep southeastern scarps up to 400m high.

Since 1984 numerous cave entrances have been discovered by Soviet speleologists in the magnificent 400m-high and 35km-long wall of Hodja-Gur-Gur-Ata, with the entrances lying at altitudes of 3,200–3,800m a.s.l. Groundwater discharge from Baisun-tau occurs through springs into the River Machai, and, to a limited degree, from the base of the wall towards the southeast. The largest spring, with a flow rate of 1m³/sec, is located at an absolute altitude of 1,400m a.s.l. Thus, the elevation difference between the cave entrances and the karst base level exceeds 2,000m.

This Report summarizes the history of exploration in this exciting region, and presents the findings of recent expeditions.

Baisun-tau – short history of exploration

Members of every caving club have ambitions to find a region with the potential of holding the world's biggest and deepest cave system. The ambitions of the Ekaterinburg Speleological Club (ESC), formerly the Sverdlovsk Speleological Club (SSC; see Ekaterinburg Speleological Club http://www.sgs.su/) started to approach reality during the 1980s, when its first expeditions visited the Baisun-tau and Surkhan-tau mountain ranges in the Surkhandar'inskii region of Uzbekistan (Fig.1). Potential in the area was found to be more than exciting.

Between 1981 and 1984 the early ESC expeditions focussed on the Ketmen' Chapty mountain range, where *Ural'skaya Cave* was found and explored to a depth of −565m. All other searches for new caves on Ketmen' Chapty proved fruitless.

Exploration of the Hodja-Gur-Gur-Ata range began in 1984 during the expedition led by Victor Dianov (ESC). While the bulk of the expedition team excavated sinkholes on the Ketmen' Chapty plateau, two cavers from the Urals – Sergei Matrenin and Igor Lavrov – journeyed to the Hodja wall in search of new caves. This trip was a great success, with several cave entrances (later *Berloga*, *Yubileynaya* and *Sifonnaya* caves) being found in the wall near the Katta-Tash summit.

Festival'naya Cave, currently the largest cave on Baisun-tau, was found the following year (1985) during the first full-blown expedition to Hodja-Gur-Gur-Ata, led this time by Aleksandr Babanin (ESC). The discovery of *Festival'naya Cave* marked the beginning of the regular exploration of Baisun-tau, which continued until 1991 (Fig.2). Over that period, *Festival'naya* was the main focus of cavers' efforts, and by 1990 it had become the *Festival'naya–Ledopadnaya* cave system, with 12.5km of explored passages and a depth of −625m. Other caves (*Yubileynaya*, *Uchitel'skaya*, *Isetskaya*, *Dark Star*, *Sifonnaya*, *Tonnel'naya*, *Podarok* and *Berloga*) were explored and surveyed during these expeditions, while a number of entrances high in the wall remained unexplored.

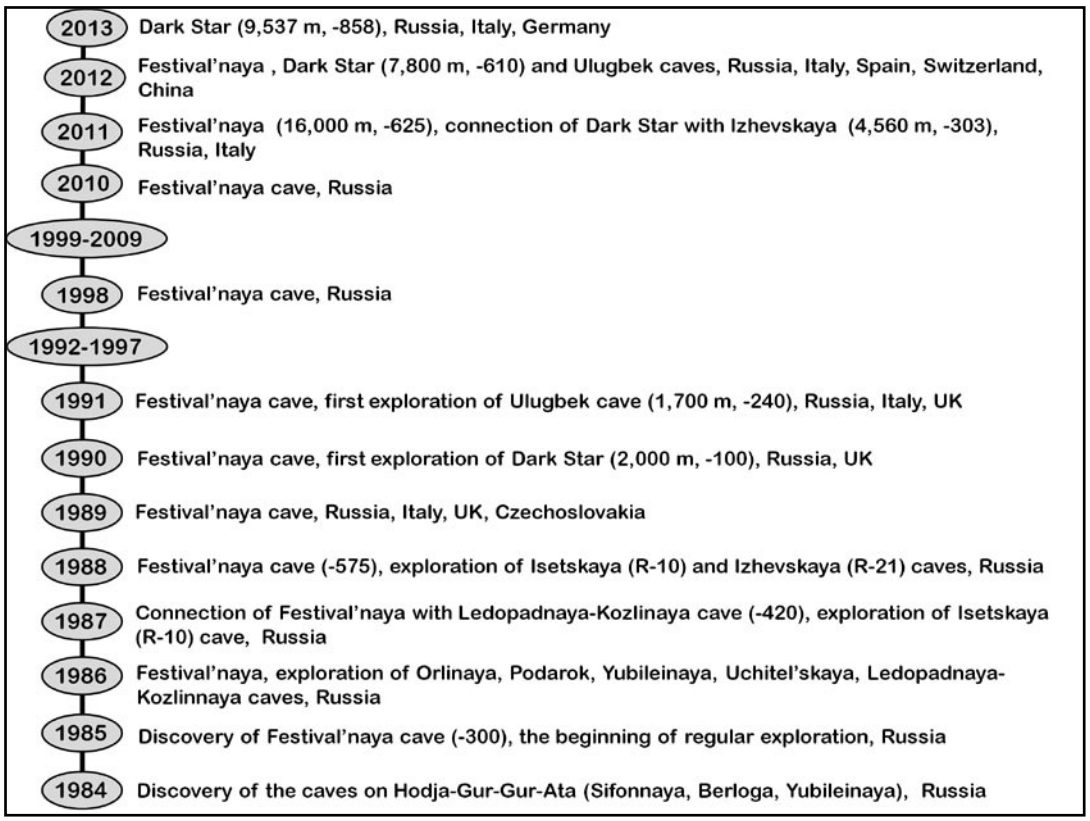


Figure 2: *Simplified time line of cave exploration in the Baisun-tau area of Uzbekistan, indicating the nationalities of expedition members.*

Over those years the Baisun-tau explorations were the result of joint efforts by cavers from many cities within the Ural region, including Ekaterinburg (formerly Sverdlovsk), Chelyabinsk, Orenburg, Magnitogorsk, Perm, Berezniki, Kizel, Gubakxa, etc, as well as from those from Izhevsk, Moscow and St Petersburg (formerly Leningrad). Cavers from Italy and England also visited the caves and made contributions to the research (see Bernabei and De Vivo, 1991, and Tsurikhin *et al.,* 2012 for more detailed accounts).

During 1985, cavers from the Ural region began to explore *Boi-Bulok Cave* on the near side of the Surkhan-tau mountain range. In total 14 expeditions were organized to *Boi-Bulok* and as a result the cave reached a depth of 1,415m, making it the deepest cave in Central Asia (Klimchouk, 2004; Bernabei and De Vivo, 1991).

Results achieved during the Baisun-tau and Surkhan-tau explorations were astonishing, especially considering the harsh climatic conditions, frequent lack of water, high altitude, remote locations of the caves, and heavy, old-fashioned caving equipment, including the use of steel cables for rigging. The expeditions were well supported by cavers from Tashkent and by local people from the small town of Baisun and the village of Duibolo.

During the period from 1992 to 2009, exploration virtually came to a halt, with just one expedition taking place, in 1998. Otherwise the region including Baisun-tau and Surkhan-tau was inaccessible to cavers because of the political situation in Uzbekistan. Finally, in 2010, a reconnaissance expedition to Hodja-Gur-Gur-Ata, led by Vadim Loginov (ESC), showed the feasibility of returning to the region to resume exploration. During this expedition new and more convenient routes were established to the wall and plateau, and a new source of fresh water for the basecamp was found. Three more expeditions followed, in 2011, 2012 and 2013. Cavers returned to Baisun-tau equipped to modern standards, with solar panels, drills, lightweight gear and food. Old friendships with locals were renewed and a new era of exploration began.

Whereas in 2010 the expedition work was still focussed on *Festival'naya*, in 2011 efforts were divided between *Festival'naya* and *Dark Star*, and in 2012 between *Festival'naya*, *Dark Star* and *Ulug-Bek* caves. During the last four years (2010–2013) more than 3.5km of passages were added to the *Festival'naya–Ledopadnaya* survey and now the cave's length exceeds 16km. In 2013 the expedition's focus shifted entirely towards *Dark Star*. Work in *Dark Star* and *Ulug-Bek* demonstrated the great potential of both caves, with multiple leads remaining for future exploration.

Dark Star: a history of exploration

The early days – *Dark Star* in 1990-91

The story of *Dark Star* began in 1990, when members of the British expedition ASPEX 90 (Anglo-Soviet Pamir Caving Expedition) reached the cave's entrance for the first time. Located at 3,550 m a.s.l., the 60m-high and 7m-wide entrance is some 160m above the base of the Baisun-tau wall. Three other entrances, named *Capricorn 1*, *Red Dwarf* and *Cancer*, were located at 3,600m a.s.l., in the wall nearby. British cavers surveyed 2,086m of passages to a depth of −83m (Fig.3). Running parallel to the wall (striking SW–NE), the cave's main passage, which represents an old, relict meander with a thick (c. 30–40cm) layer of dry limestone dust on the floor, numerous frozen lakes, and ice crystals on the walls, is exceptionally cold, with sub-zero temperatures and a strong draught. Exploration by the British cavers stopped at a T-junction where a deep pitch led towards the wall, and a climb up led deeper into the massif. Both leads were left unexplored due to lack of time and equipment.

Returning to continue exploration of *Dark Star* in 1991, the British ASPEX 91 expedition found that deep water from melted ice on the lakes made it impossible to reach the end of the cave (Tsurikhin *et al.,* 2013). Following the British expedition, political and economic instability in the former Soviet Union precluded any additional explorations, and it would be 20 years before a new era of exciting and challenging expeditions could begin.

Dark Star reloaded – explorations in 2011

In summer 2011, cavers returned to *Dark Star* during a joint Russian–Italian expedition that included 19 Russian and 3 Italian cavers. The exceptionally hot and dry summer led to there being a complete lack of water on the plateau during the expedition. While two Russian groups continued the exploration of *Festival'naya* according to plan, a third (Russian–Italian) group, known as Camp Central, was forced to camp near the only source of water at the base of the wall, focussing attention on the exploration of *Dark Star*. All the lakes in the cave were frozen solid, and the team quickly reached the T-junction where the British cavers stopped in 1990. The junction was given the name *20 Years Later*. On the way, two side passages in the *Frozen Back* gallery were explored; one of them, named *Po-Sokolovski*, ended as another entrance (*Vino Rosso*) on the wall. Another passage (*Orenburgskii'*), which also led towards the wall, was not explored to its end (Fig.3).

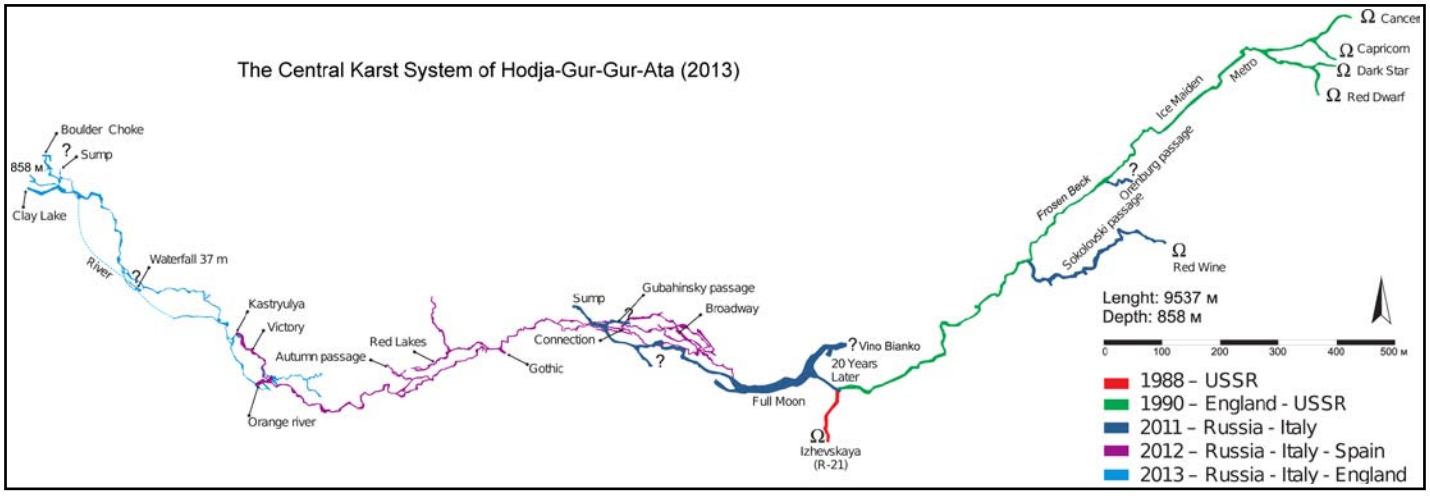


Figure 3 (above): *Plan of the Central Karst System of Hodja-Gur-Gur-Ata, 2013. The passages explored and surveyed in 1990 by the British ASPEX 90 expedition were re-surveyed in 2011. Colours shown in the key indicate parts of the cave explored and surveyed in the years shown, and the nationalities of the cavers involved.*

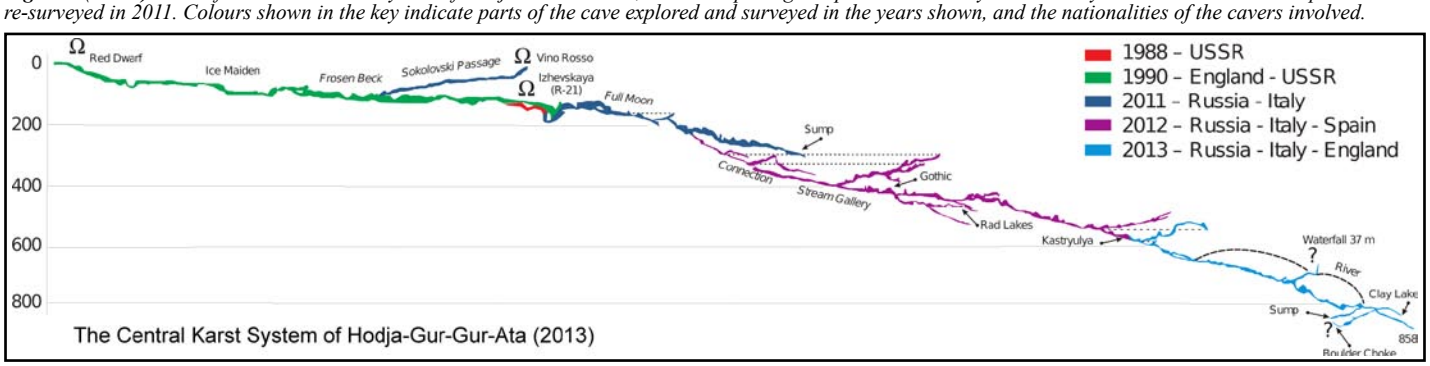


Figure 4: *Longitudinal section of the Central Karst System of Hodja-Gur-Gur-Ata, 2013. Colour coding matches that used on the plan (Fig.3).*

The Izhevskaya (R-21) entrance to the Dark Star (photo by A Votintseva, 2012).

Intermediate camp at 2,700m a.s.l. (photo by E Tsurikhin, 2012).

Base camp "Central" at 3,200m a.s.l. (photo by E Tsurikhin, 2012).

After descending a 30m-deep blind shaft at the *20 Years Later* junction, the cavers climbed 15m up to the main passage that continues on the far side of the shaft. They entered a wide, relict gallery that ended after 100m in another spectacular entrance on the wall. Subsequently it became clear that this passage had previously been explored and surveyed from the wall to the pitch in 1988, by a Russian team from Izhevsk. They named this passage *Izhevskaya Cave* (*R21*). Unfortunately, their survey documents have been lost.

The most important discovery was made during the last days of the expedition, when an ascending passage in *20 Years Later* was climbed. A wide gallery, leading into the massif, ended in a vast chamber, named *Full Moon Hall*, 100m long and up to 30m high, with a magnificent glacier and walls covered in spectacular ice flowers. From *Full Moon Hall* the main passage continued deep into the massif, where it ended, after a series of pitches and horizontal passages, in a sump at −308m (Fig.4). On the way to the sump, numerous side passages were explored, most of them not to the end, providing plenty of leads for the next expedition.

The surveying team camped underground not far from the entrance and re-mapped 2km of the known part of the cave explored by the British team in 1990 and surveyed another 2km of passages to the sump. It was decided that *Dark Star* would be called the *Central Karst System of Hodja-Gur-Gur-Ata*. *Dark Star* now included six entrances (*Izhevskaya* (*R21*), *Dark Star*, *Capricorn 1*, *Red Dwarf*, *Cancer* and *Vino Rosso*), with a total surveyed length of 4,560m and a depth of −303m from the highest entrance.

Dark Star 2012

In 2012 the ESC launched the largest Baisun-tau international expedition to date, led by Vadim Loginov and including 29 participants from five countries and eight Russian cities. Thanks to efficient organization and the use of a new, convenient, access route, it was possible to reach the base of the wall in the record-breaking time of just four days. This journey required two flights (Ekaterinburg–Tashkent and Tashkent–Karshi), and two road trips (Karshi–Boisun, by car, and Boisun to the "end of the road", by truck). Donkeys were used to help cover the several kilometre-long stretch from the road to the intermediate camp at 2,700m a.s.l. From this camp, several trips were made on foot to cover the remaining 500m difference in altitude to the base of the wall at 3,200m a.s.l. (Camp Oasis), ferrying all the equipment to the research area.

The swift progress, covering 2,000m of altitude in just two days, caused some problems with acclimatization among expedition members, including altitude sickness, stomach upsets and high temperatures. Further inconvenience was suffered because a major mudslide had completely destroyed the original Camp Oasis at 3,200m a.s.l. near *Festival'naya Cave*. A serious issue was the discovery that half of the ropes hidden in *Festival'naya* at the end of previous year's expedition were missing – a loss that threatened to limit progress. An emergency trip into *Festival'naya* to de-rig some pitches, and a two-day run by two expedition members to Boisun town to fetch an additional 200m of rope alleviated the situation somewhat. Nevertheless, shortage of rope was a recurrent theme of discussions during the expedition.

Exploration was carried out by three groups, which focussed on the *Festival'naya*, *Dark Star* and *Ulugbek* caves. Each group had an extensive list of objectives, most of which were fulfilled. In addition to cave exploration, a scientific programme was carried out, led by the Swiss and Chinese members of the expedition. The scientific tasks included installation of several data loggers and collection of drip-, rain- and snow-melt water, stalagmite samples, and host rock samples for subsequent palaeoclimatological investigations.

The *Ulugbek* team of 8 cavers set up a base camp on top of the wall (3,800m a.s.l.). Conditions at the camp were extremely harsh, with cold weather and wind hampering progress. Additionally, the cave entrance was blocked by an ice plug that took three days to break through. As a reward, a new and more convenient entrance to the cave was found, along with several promising leads for future exploration. A few other cave entrances on the plateau were also located and explored.

According to plan, the *Festival'naya* team set up an underground camp and continued exploration of leads found in 2011. A second group from the same team made a surface survey of the *Festival'naya* entrance and tied it to the entrances of the nearby *Yubileynaya* and *Berloga* caves. This work, by a group of 8 cavers, resulted in more than 2km of passages being explored and surveyed.

The *Dark Star* team of 13 cavers set up a very comfortable camp near the *Izhevskaya* (*R12*) entrance to *Dark Star*. There was no shortage of water during the expedition because a large amount of snow had accumulated during the 2011–2012 winter.

While the *R12* entrance to *Dark Star* was being rigged, several short trips were made to the nearby *Tonnel'naya Cave,* with the aim of collecting data for the palaeoclimate research programme mentioned above. Temperature, humidity and drip detectors were set up in *Tonnel'naya Cave* and samples of water, freshly fallen snow and old snow, as well as ice, were collected from a number of underground and surface sites.

An acclimatization trip to *Dark Star* revealed that the old part of the cave was inaccessible, because the surfaces of all the frozen lakes had turned to mushy ice. Therefore, all efforts were focussed on the new part of the cave found in 2011. One of the main leads, a side passage at −240m on the route towards the sump, ended at an unexplored pitch. On the first trip, a wide gallery with a series of small pitches was discovered, ending in a chamber with two passages, *Corallite Meander* and *Broadway*. *Corallite Meander* is a narrow, strenuous rift with numerous up and down climbs and squeezes. Its walls are thickly covered with a crust of corallites, too fragile to support the weight of a caver but sharp enough to cut an oversuit. After about 300m *Corallite Meander* joined a wide gallery with a stream (2–3 litre/sec discharge) (*Stream Gallery*).

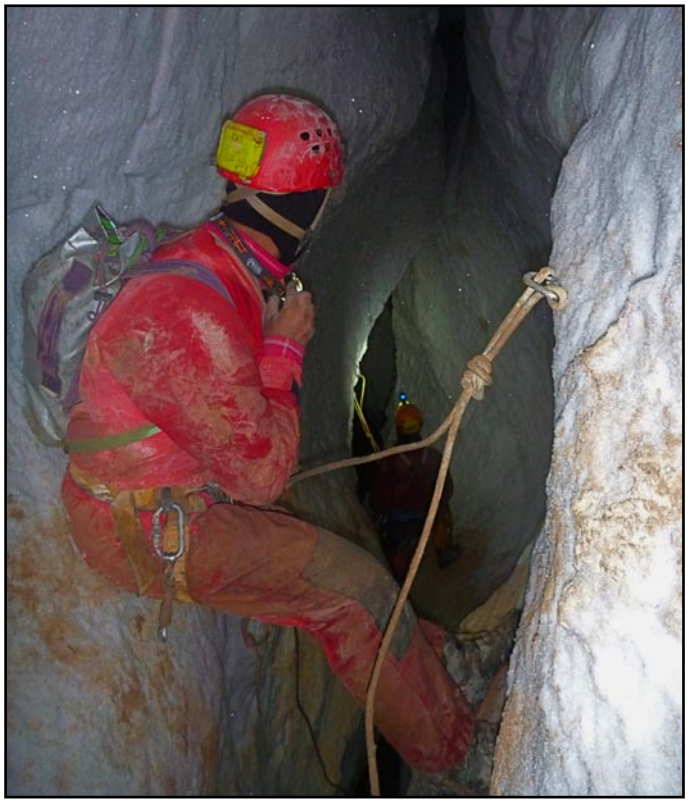
At this point it became clear that an underground camp should be set up to facilitate work by the surveying team. The camp was established not far from the sump, at the only suitable spot, and it could accommodate 3–6 cavers. The location was not ideal, as the camp was damp and draughty, and high water levels complicated the access route. A total of 6 traverse lines were rigged to by-pass the lakes. Nevertheless, use of the camp was justified because an underground team was able to survey twice as much as cavers coming from the surface camp.

Broadway passage ended at a pitch, and then continued below as a wide gallery with side passages. This gallery was eventually connected with *Corallite Meander* at a complicated junction called *Connection*. The upstream part of *Stream Gallery*, at the end of *Corallite Meander*, was also connected with the same gallery not far from the end of *Broadway* and provided an easy shortcut, by-passing the strenuous *Corallite Meander*.

The most promising direction, however, was the downstream part of *Stream Gallery,* which ended after 500m at an impassable squeeze only 10cm high, with the stream disappearing into it at −540m. Not far from the end of *Stream Gallery,* the small but extremely well decorated and colourful *Red Lakes Series* was discovered. The *Red Lakes Series* is a twisting passage with a thick false floor and numerous lakes up to 15m deep (measured using a laser distometer). The entire passage is covered with a spectacular calcite crust in many shades of red, purple and deep violet. Most of the walls and floor are decorated with coloured crystals and splendid formations, especially at the end of the passage, described as being like "red caviar" in one of the chambers.

As it became clear that the end of *Stream Gallery* could not be pushed further, the exploration was focussed on the upper part of the *Stream Gallery* near *Gothic Chamber* at −450m. Though this was not very promising at the beginning, it eventually ended in a new and extensive part of the cave during the last few days of the expedition. This new part of the cave includes a wide passage with several pitches and numerous unexplored side branches. Following the main gallery the leading team reached a depth of −610m (Fig.4) where they had to stop at a 30m-deep pitch due to lack of ropes and time. On the final day of the expedition all cavers were working in the new part of the cave, surveying the main passage before dismantling the underground camp.

In total more than 4km of passages were surveyed in *Dark Star* in 2012 and the cave length reached 7,800m (Fig.3). Almost all cavers were involved in surveying during the 2012 expedition, with up to 5 teams working in different caves at the same time. As a result, the expedition surveyed more than 6km of passages.



On the way to "20 Years Later", Dark Star (photo by S Guarniero, 2012).

Dark Star 2013

In 2013, the ESC organized a relatively small expedition, led by Ivan Russkikh, with 16 participants from Russia, Italy, and Germany. Due to the small size and short duration of the expedition (19 days), its efforts were concentrated on *Dark Star*. The journey to *Dark Star* was hampered by the loss of the Italian team's luggage during air transit and delays with registrations caused by the national celebrations marking the end of Ramadan.

Eventually the base of the wall was reached on the fifth day of the expedition. Several people experienced health issues, including the customary acclimatization to high altitude, stomach upsets and high temperatures. Unusually cloudy and rainy weather in August 2013, augmented by sudden storms, strong wind and hail, added more tribulation to life at the base camp.

Plans for the expedition included exploration of the most promising leads in *Dark Star*, the main one being at the far end of the cave, as well as filming the exploration of the new parts of the cave by the Italian team. On the seventh day of the expedition, a very comfortable underground camp was set up in *Gothic Chamber* at −450m, with two tents for up to 9 people. Exploration work was organized into shifts, with a leading team exploring and rigging the main passage and surveying teams exploring the side passages.

The pitch, named *Kastryulya*, where exploration had stopped at −610m in 2012, was rigged, and the main passage beyond was found to continue into the massif, following the dip of the strata. After a series of several 10 to 20m-deep pitches separated by stretches of galleries, the main passage ended in several low and narrow passages floored with shingle at a depth of −858m (Fig.4). In one of these passages the sound of running water could clearly be heard behind the wall, but the tight passage leading towards the sound of the water was impassable.

Lake in the Red Lakes Series (photo by E Tsurikhin, 2012).

Curtains in the Red Lakes Series (photo E Tsurikhin, 2012).

Formations in Sugar Factory passage, Red Lakes Series (photo by E Tsurikhin, 2012).

Red Lakes Series (photo by E Tsurikhin, 2012).

Other side passages near the bottom were explored in the hope of finding a by-pass. One of the passages led to a high narrow rift with running water that ended up in a sump at −825m. According to the survey (Fig.3), it is highly probable that the water heard at the end of the lead at −858m is the same stream. Because the main passage could be pushed no further without diving equipment, further exploration was focussed on side passages.

Most of the side passages below *Kastryulya* looped back to the main passage after only a few metres. One passage led to a duck at −646m and was not pushed any further due to lack of a dry suit. Another side passage at a depth of −712 m ended in a short upward climb beyond which the passage divided. The left-hand passage ended in a high chamber with a 30m-high waterfall entering from the ceiling and the stream going down a high rift. The waterfall was not climbed due to lack of time and will be one of the main leads for the next expedition. The right-hand passage led to the other side of the previously discovered duck (Fig.3).

Before dismantling the underground camp, a trip was made to the *Red Lake Series* to collect samples of the bacterial growth on the passage walls, discovered in 2012. Samples were preserved in four different buffers for later investigation of the cave microflora using whole genome sequencing.

At the beginning of the expedition a day trip to the nearby *Tonnel'naya* and *Sifonnaya* caves was made with the aim of taking water samples and collecting the temperature and humidity detectors installed in *Tonnel'naya* in 2012. Water samples were also collected in *Dark Star,* along with rain and stream water from the surface.

In total, the 2013 surveying teams mapped 1,740m of new passages in *Dark Star*. Plans for the next expedition include exploration of the two most promising leads in *Dark Star*, the waterfall and the sump at the far end of the cave.

	Year of exploration			
	1990	2011	2012	2013
Length, m	2086	4560	7800	9537
Depth, m	−83	−303	−610	−858

Table 1. Increasing length and depth of the Dark Star cave, 1990–2013.

Expedition team 2012 (photo E Tsurikhin, 2012).

Surveying team in "Broadway", Dark Star (photo by A Votintseva, 2012).

Conclusions

As a result of the recent expeditions in 2011–2013, the *Central Karst System of Hodja-Gur-Gur-Ata* now includes 6 known entrances with 9,537m of surveyed passages to a depth of −858 m (Table 1). The system is developing in two main directions: (1) along the bedding – parallel to the wall and (2) following the dip of the strata into the massif at an angle of 22–28°. The most remote part of the system is only 1km away from *Isetskaya Cave* and only 1.2km from *Ledopadnaya Cave*, which is a part of the *Festival'naya–Ledopadnaya* system. Finding a connection between the two cave systems is probably only a matter of time. Such a connection would establish a cave system more than 26km in length.

Exploration of caves on Baisun-tau will continue in 2014.

Acknowledgments

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Local young woman in Duibolo village (photo E Tsurikhin, 2012).